

Original scientific paper**ORIGINAL SCIENTIFIC PAPER****Borislav Cicović, Slavko Zdrale**

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RELATIONS OF MORPHOLOGICAL CHARACTERISTICS WITH THE RESULTS OF FLEXIBILITY IN JUDISTS**Abstract**

The research was carried out on the sample of 94 examinees, high school students, aged 15 and 16 years, \pm 6 months, who are a part of the training process with three classes a week in judo clubs in Istocno Sarajevo. The main goal/aim was to establish the statistically significant canonic relations between the morphological characteristics (as a predictor system) and the individual criteria variables of the flexibility dimension in judists, in order to establish the existence of the possibility of forming more rational procedures for optimal planning, programming and control of the training/practice, with the aim of checking the coherence of their development and, if possible, determining the better and appropriate projections of their further development. As the predictor system 10 anthropometric measures of the morphological dimensions were used: 1. longitudinal dimensionality of the skeleton: body height (AVIST), leg length (ADNOG) and arm length (ADUŽR); 2. circular dimensionality and body mass: medium/mean value circumference of the chest (AOGRK), upper arm circumference (AONDL), shin circumference (AOPTK) and body mass (ATEŽT); 3. subcutaneous adipose tissue: stomach skin folds (ANTRB), upper arm skin folds (ANNDL); shin skin folds (ANPTK). For the estimation of flexibility, as a criteria system, the following variables were used: standing hamstring stretch on a bench (MDPK), splits (MŠPA) and shoulder stretch with a baton (MISK). The results of the research were processed in the programme for statistics „Statistica“ 8.0 for Windows for the calculation of basic statistic parameters and canonical correlational analysis of the morphological characteristics and flexibility. The gathered results of the research showed, based on the coefficient of canonical correlation (Can. R) and the percentage of the shared variance (Can. R²), that the results of the flexibility tests of the examinees are, to a great extent, statistically significantly manifested ($P = .030$) depending on their morphological characteristics.

Key words: morphological dimensions, flexibility, canonical correlational analysis, judists.

1. INTRODUCTION

Judo as a sport activity has a positive influence on the anthropological characteristics of a personality is one of the leading motoric activities and there is almost no dimension it would not have a positive effect on. Confirmation for these

assets/values of judo as a means of positive transformation of the abilities and characteristics of children, youth and student was provided by the following researches (Ćirković, 1996; Obadov, 2005; Cicović, 2008; Kuleš, 2008; Bratić i sar., 2008 and others). These authors show that greater positive changes in the anthropological status of children, youth and students are present with programmed judo training than with the programmed traditional methods of exercise during the physical education classes.

Through the process of learning and practicing judo, which is a very demanding and strenuous sport not only motoric and cognitive abilities are affected, but the formation of a specific structure of abilities and personality characteristics. During judo training one acquires/builds self-confidence, pain and stress resistance, working and the habits concerning hygiene are created, self-criticism and self discipline, as well as other positive characteristics, are developed. Negative characteristics are lessened or completely removed, with the appropriate help of the coach, through practical and verbal training methods.

Flexibility is the ability of performing moves with great amplitude which is dominant, determined by the elasticity of ligaments, tendons and muscles and by the joint structure (Pržulj, 2006). Free joint movement, which is a measure of the flexibility of the joint systems, is a special characteristic of judists.

Judists have a great flexibility of the shoulders neck and lumbar part of the spine, toes and hands, which helps the throw by hamstring stretch, torso rotation, backwards stretch, movability on the floor and other motoric actions. The insufficient level of the flexibility dimension affects through poor coordination, technique and slow learning of motoric movements, lessened ability of strength development and the speed of movements in judists.

More flexible judists achieve a greater speed of performing the judo technique and a greater starting speed, better adaptation to the opponent during the throwing time and thus a more efficient fight. Flexibility in that case should be somewhat bigger than the demanded maximal amplitude. One could influence the increase in flexibility of a joint due to the low coefficient of innateness (80%), however, even beside that, a poor built of the joints could limit one's development.

A few researches have been conducted into the relations of the morphological characteristics with the flexibility for the population of the high school students, involved in the training process in judo clubs.

Having in mind that the morphological and motoric space are interrelated and affect significantly the result efficiency of the training content it could be presupposed that the morphological characteristics have a great part in the results of the judists' flexibility.

The problem of research is questioning the important relations between the latent dimensions of the appropriate morphological characteristics and dimensions of flexibility, which is relevant in certain activities in judo fights, in order to, on one hand, retain and check the wanted anthropological harmony in the judists of this age,

and on the other hand to realize the wanted training technology and the development of the flexibility dimension.

The main goal of the research is determining the statistically significant canonic relations between the morphological characteristics (as a predictor system) on the specific criterion variables of the dimension of flexibility of judists, involved in judo clubs, in order to create the possibility for the formation of rational procedures for optimal planning, programming and control of training, with the aim of checking the coherence of their development and, if possible, determine the better and more appropriate projections of their further development.

Determining the relations of the morphological characteristics with the results of the motoric flexibility represents an actual and practical problem, that is of great significance primarily because of its possibility to form rational procedures for optimal orientation and selection of young athletes, planning, control and programming of the training process, as well as an efficient monitoring of the development of anthropological characteristics during the training process.

2. METHOD OF RESEARCH

This research was carried out on the sample of 94 examinees, high school students, aged 15 and 16 years, ± 6 months, involved in the training process for three classes a week in the judo clubs of Istočno Sarajevo.

In order to determine the relations between the morphological characteristics and flexibility of the judists 10 anthropometric measures of the morphological dimensions: 1. longitudinal dimensionality of the skeleton: body height (AVIST), leg length (ADNOG) and arm length (ADUŽR); 2. circular dimensionality and body mass: average/medium circumference of the chest (AOGRK), circumference of the upper arm (AONDL), shin circumference (AOPTK) and body mass (ATEŽT); 3. subcutaneous adipose tissue: skin folds of the stomach (ANTRB), skin folds of the upper arm (ANNL); skin folds of the shin (ANPTK). The suggested model of the sample of anthropometric measures for the assessment of morphological characteristics was used based on the recommendation of the International Biological programme (*Lohman, Roche i Martorell, 1988*).

For the assessment of the flexibility the following variables were used: hamstring stretch on a bench (MDPK), splits (MŠPA) and shoulder stretch with a baton (MISK). The suggested model of the flexibility tests was taken from the research by *Kurelić and associates (1975)*.

The results of the research were processed by the statistical programme „Statistica“ 8.0 for Windows used for the calculation of the basic statistic parameters and canonical correlation analysis of the morphological characteristics and flexibility.

3. RESEARCH RESULTS

Table 1. Basic statistic parameters for the evaluation of morphological dimensions

Measures	N	Mean	Min.	Max.	Std.	Skewn.	Kurtos.
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					Dev		
AVIST	94	176.34	165.00	189.00	4.15	0.424	1.616
ADNOG	94	97.63	92.00	103.00	5.57	0.562	1.853
ADUŽR	94	78.56	72.00	84.00	2.94	0.043	0.264
AOGRK	94	86.74	78.00	97.0	4.13	0.554	0.773
AONDL	94	25.68	21.00	29.00	7.04	0.124	1.084
AOPTK	94	34.23	31.00	38.00	8.02	0.050	1.752
ATEŽT	94	66.82	58.00	83.00	5.11	0.052	0.726
ANTRB	94	10.35	7.00	16.00	1.42	-0.143	-0.610
ANNDL	94	8.76	5.00	13.00	5.77	-0.793	-1.127
ANPTK	94	9.82	6.00	14.00	8.95	-0.325	-1.413

Legend: mean value (Mean), minimum (Min.), maximum (Max.), standard deviation (Std. Dev.), skewness (Skewn.), kurtosis (Kurtos.)

The results (table 1) gathered from the examinees in the area of the morphological dimensions show that there are no significant deviation of the anthropometric measures results from the normal distribution having in mind that the values of skewness do not go over 1.00 for any measure, as well as the kurtosis values which are in the range below the normal distribution value of 2.75, which makes the distribution platykurtic and fuzzy/spread out.

Table 2. Basic statistic parameters for the estimation of the flexibility dimension

Variable	N	Mean	Min.	Max.	Std. Dev.	Skewn.	Kurtos.
MDPK	94	48.62	37.00	54.00	4.62	-0.583	1.467
MŠPA	94	165.24	132.00	187.00	4.01	0.351	1.572
MISK	94	78.56	62.00	92.00	3.49	-0.432	-2.038

Legend: mean value (Mean), minimum (Min.), maximum (Max.), standard deviation (Std. Dev.), skewness (Skewn.), kurtosis (Kurtos.)

The results (table 2) gathered from the examined in the space of flexibility variables show that there are no significant deviation of the results of normal distribution having in mind that the value of skewness do not go over, for any anthropometric measure, 1.00, as well as the kurtosis values which are in the range below the normal distribution value of 2.75, which makes the distribution platykurtic and fuzzy/spread out.

Table 3. Canonic correlational analysis of predictors and criteria

1	Can.R	Can.R²	Chi-sqr.	df	P- Level
0	.62	.46	57.23	42	.030*

Legend: coefficient of canonical correlation (Can.R), coefficient of determination (Can.R²), Chi-square test (Chi-sqr.), degree of freedom (df.), significance (P- Level)

The results of the canonical correlational analysis show (table 3) that there is statistically significant part of canonical factors in the relations between the predictor systems, who make up the anthropometric measures for the estimation of morphological dimensions and criteria forming the variables for flexibility estimation.

The canonical factor significantly explains the level of connectedness between the set of predictor measures of morphological dimensions and criterion (Can.R=.62),

as well as their shared variance (Can. $R^2=.46$), which explains the effect of morphological characteristics on the success of the flexibility results by the determination coefficient with 46%. The importance of the determination coefficient was tested by the Bartlett's X^2 test which has a high value (Chi-sqr. 57.23), thus making the possibility for error for the rejection of the hypothesis of whether the function is significant or not, set between the predictor and criterion ($P=.030$) at the level of 97%.

Having in mind the value of the canonical correlation coefficient (Can. R) and the shared variance percentage (Can. R^2), it can be concluded that the flexibility tests of the examinees will be to a great extent manifested depending on their morphological dimensions.

Table 4. Canonical factors of anthropometric measures of morphological dimensions

Anthropometric measures	Root 1
AVIST	0.38
ADNOG	0.45*
ADUŽR	0.48*
AOGRK	0.37
AONDL	0.32
AOPTK	0.28
ATEŽT	-0.34
ANTRB	-0.51*
ANNDL	-0.28
ANPTK	-0.35

Observing the structure of canonical factors (table 4), it is perceived that the primary factors of the morphological dimensions measures do not participate to the same extent in the formation of the canonical factor's structure. It can be said that a great number of factors affects the efficient performance of the flexibility variables, but their effect is different. The greatest influence on the canonical factor have the stomach skin folds (ANTRB -0.51), arm length (ADUŽR 0.48) and leg length (ADNOG 0.45).

Table 5. Canonical factors of flexibility variables

Variables	Root 1
MDPK	0.56*
MŠPA	0.45*
MISK	-0.28

Canonical factors of flexibility (table 5) show the existence of the one-dimensional structure of space. The success factor of flexibility is statistically significantly defined by the hamstring stretch on a bench test (MDPK 0.56) and splits (MŠPA 0.45), and to a lesser extent by the variable shoulder stretch with a baton (MISK -0.28).

Table 6. Crosscorrelational analysis of the morphological dimensions and flexibility

Anthropometric measures	MDPK	MŠPA	MISK
AVIST	0.23	0.18	0.14

ADNOG	0.47	0.39	0.45*
ADUŽR	0.36	0.38	0.42*
AOGRK	0.22	0.28	0.19
AONDL	0.15	0.18	0.26
AOPTK	0.28	0.26	0.25
ATEŽT	0.15	0.15	0.16
ANTRB	-0.37	-0.38	-0.35*
ANNDL	-0.25	-0.27	-0.25
ANPTK	-0.21	-0.19	-0.23

A different level of the correlation coefficients of the examinees could be noticed, in the matrix of cross correlation of the measures of morphological dimensions and the variables of the success in flexibility (table 6). Anthropometric measures of the leg length (ADNOG), arm length (ADUŽR) and stomach skin folds (ANTRB) in correlation with the flexibility tests point to the greatest connectedness.

4. DISCUSSION OF THE GATHERED RESULTS

Judo falls into the group of polystructural acyclic sports in which acyclic unpredictable movement dominates, where the result is, most often, a binary variable (win - loss), and movement is performed and limited in a direct fight with the opponent.

Modern judo demand that the fight is carried out in a very fast manner and that it has a great number of technical and tactical activities, and the dominant role, out of the specific motoric abilities, has speed, coordination, explosive and repetitive strength and speed and strength endurance.

Even though flexibility has no leading importance in a judo fight, its development is needed. This is precisely why there is not one training session without a relatively big number of these exercises, of the general or specific character in the introductory or finishing part of the session. Without its use it is hard to speak of the rational performance of judo technique. Rational and economical performance of the techniques, for example, ura nage, o uchi gari, sode tsuri komigoshi, kata guruma etc., depends to a great extent on the flexibility (*Obadov, 2005; Kuleš, 2008; Bratić, 2008*).

From the results shown in table 3 it is clear that the relation between the system of anthropometric measures for the estimation of morphological dimensions, as a predictor system, and the variables for the estimation of flexibility, as a criterion system for judists, is .62 and that is significant at the level of .030.

Furthermore, the results shown in table 4 canonical factors of the anthropometric measures of morphological dimensions, show the statistically significant correlation of the leg length (ADNOG), arm length (ADUŽR) and stomach skin folds (-ANTRB) marked with an asterisk (*) with the canonical factor.

In the matrix of the canonical factors of the flexibility (table 5) there are statistically significant correlation of the variables hamstrings stretch on a bench

(MDPK) and splits (MŠPA), also marked with an asterisk (*) with the canonical factor, apart from the variable shoulder stretch with a baton(MISK).

In the matrix of croscorelation of the measures of morphological dimensions and variables of success in flexibility (table 6) in the examinees, it has been noticed that the anthropometric measures of leg length (ADNOG), arm length (ADUŽR) and stomach skin folds (ANTRB) in correlation with the flexibility tests show the greatest connectedness.

Newer scientific research indicate that during many years of the training process it is important to influence the flexibility from the early stages since then, according to the sensible phases (*Pržulj, 2012*) the influence is less complex and better. In the age period of 11 to 14 years old the greatest influence can be done by the sports gymnastics exercise, sports games and swimming. A quality development of flexibility at this age will ensure that, in the later phases of growth and development and proportionally to the body dimensions, it maintains the reached level.

The results of other research (*Malacko i Popović, 2001; Obadov, 2005; Bratić and associates., 2008.*) show that during the flexibility training judist develop two main forms of flexibility: active and passive. The first one is achieved through the activity of one's own musculature by the full volume of movement, active method, and the other one by weights, a partner or one's own muscles and weight, or the so called, passive method. According to these authors, both forms of flexibility are important for judo: the first one for the performance of th techniques in the standing position and the other for the floor exercise technique, and they should be combined during the training session, because they are in a relatively great correlation.

Applying these two methods and with a smaller intensity the reserve of flexibility is increased, the negative influence of hypertrophy and other muscular adaptation during strength development lessened, and the tension of muscles relieved which promotes a better circulation and nerve conduction. The mentioned decrease of muscle tension adds to the decrease in tiredness and helps in the ejection of metabolic waste (lactic acid).

The basic means for the development of flexibility are the exercise of a dynamic and static stretching. Exercises for increasing dynamic flexibility, especially those with a smaller load(medicine ball, smaller weights) are much more important and along with flexibility increase the strengths of agonists and the ability of the dynamic stretching of antagonist.

The problem of musculature relaxation of the antagonist, as the conditions of flexibility increase, is solved in practice in two ways. Practicing the conscious musculature relaxation (avoiding antagonist contraction) which ensures the rise in flexibility during the exercise and relaxation in a sauna or a warm bath enables a preventive relaxation for the flexibility training that follows it. It is necessary to add that exercising gradually, rest intervals during the training session and the quality of the finishing part of the session are4 the most important for the prevention of the musculature "stiffness".

Judists, wrestlers and weight lifters use the possibility of promoting/developing their own strength at the expense of flexibility (back musculature). The children who use flexibility exercise can, in certain movements, lose the ability of strength manifestation. If the flexibility exercise are done with a maximal amplitude and a more appropriate smaller load (medicine balls and small weights) the mentioned negative training effects are avoided, and flexibility and strength are harmoniously developed (*Ćirković, 1996; Metvejev, 2000; Pržulj, 2006.*).

In a yearly cycle of training sessions, judists do the flexibility exercises daily, in every period and step. It has been set by the traditional way of exercising in this sport (*Drabik, 1996.*). Applying stretching with the intensity of 30 to 40 % subjective perception of the load, judists should perform the appropriate stretching without a strain, which decreases the development of scar tissue and micro injuries. Keeping a certain position during stretching for the period of 60 seconds helps in reshaping the system of connective tissue and muscle groups. Repeating stretching increases the adaptation of the nervous and muscle system. *Drabik (1996)* points out that during the training process one should be aware of the judists performing the flexibility training correctly, keeping the integrity of the connective tissue and muscles, and the reserve of flexibility which aids the better achievements, that is, enables judists to perform a move without excessive effort. That reserve lessens the resistance of the muscles which are elongated in a specific phase of movement and protects the muscle from an injury.

That is why during the organization of the appropriate programme for the judists' flexibility training it is important to take care of the different loads on the connective tissue. A well devised programmes allows for a greater flexibility of the inelastic tissue (ligaments and tendons), removing of scar tissue and lowers the chance of injury cause by strain.

5. CONCLUSION

Judists with a high flexibility can perform exercise or routines on competitions more strongly, faster and more prominently. Strength, speed and stamina are the characteristics of every sport. Flexibility, however, determines the extent to which the athletes could efficiently apply the previously mentioned motoric abilities. Flexibility in the sports that require stamina and strength is of utmost importance for a "better use" of the motoric system while also ensuring the development of sports form/condition and coordination. Those athletes who have an optimal level of flexibility perform demonstration of strength in a greater number of moves which affects an increase in their speed.

The fixed relations of morphological dimensions and flexibility in this research have a theoretical as well as practical value for the training process of judists, because the results are scientific an professional information on the dimensions of the morphological characteristics that affect greatly the efficacy of the results of the flexibility variables.

The possibility is thus given to ensure that the judists, during trainings, have more space for the particularly emphasized development of the anthropometric measures which have a greater predictive value on the results of flexibility, which would affect the raise in the efficacy of the results in a judo fight. Besides, the results

of the morphological dimensions and flexibility can aid the individualization of the training process by ensuring that planning, programming, realization and control of trainings is adapted to the individual abilities and characteristics of judists.

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